Beckman Industrial™

CIRCUITMATE™ MODEL CM20 DIGITAL CAPACITANCE METER

Operator's Manual

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INSTRUMENTATION PRODUCTS DIVISION
BECKMAN INDUSTRIAL CORPORATION
A SUBSIDIARY OF EMERSON ELECTRIC CO.
BREA, CA 92621

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WARRANTY

90-Day Limited Warranty

Circuitmate™ Model CM20 Digital Capacitance Meters are warranted in entirety against any defects of material or workmanship which develop for any reason whatsoever, except abuse, within a period of 90 days following the date of purchase of the capacitance meter by the original purchaser. This warranty is extended by Beckman Industrial Corp. only to the original purchaser or original user of the capacitance meter, who must, as a CONDITION PRECEDENT TO WARRANTY COVERAGE AND PERFORMANCE THEREUNDER BY BECKMAN INDUSTRIAL CORP., complete and return the Warranty Registration Card, received on purchase of the capacitance meter.

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Beckman Industrial Corp.
630 Puente Street
Brea, CA 92621
Attention: Customer Service

In the event of replacement with a new or reconditioned model, the replacement unit will continue the warranty period of the original capacitance meter. The turnaround time for replacement units at the Service Center is typically only two (2) working days.

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BECKMAN INDUSTRIAL CORP.
Brea, California

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Section One
INTRODUCTION

The Circuitmate™ Model CM20 is a 3½-digit handheld capacitance meter designed for use by technicians, servicemen, production workers, and quality control personnel as well as engineers. The LCD display design allows longer battery life than comparable LED designs. The meter can operate either on batteries or from an optional AC/DC adaptor, making it usable almost anywhere.

Standard features are:

1. Recessed 3½-Digit LCD Display
2. Overload Protection
3. Eight Ranges — 200$_{\rho}$F to 2000μF
4. Front Panel Zero Adjust
5. Over-Range Indicator
6. Low Battery Indicator
7. Single Range Selector Switch
8. Banana Jacks as well as Lead Insertion Slots
9. Tilt Bail
10. AC/DC Adaptor Provisions

Section Two
UNPACKING/SETUP

Remove the capacitance meter from the container. The box should contain following items:

1. Capacitance Meter.
2. Test lead set (one red, one black).
3. Operator's Manual.
4. 9-volt battery (located in battery compartment).
5. Two fuses (one installed and one spare).

CAUTION

Failure to turn off the instrument before installing the battery could result in damage to the instrument if it is connected to the battery with polarities reversed.

Unpack the battery, which was placed in the battery compartment, and connect it to the battery snap. See Paragraph 5.1, Page 8.

Section Three
INSTRUMENT FEATURES

For features described in this section, refer to Figure 1. It is strongly recommended that the user read and become familiar with the contents of this section before operating the device.

1. Digital LCD Display
   Digital display has 3½-digit readout (maximum reading 1999) with decimal point, over-range, and low battery indicators.
2. Power Switch
   Use this switch to turn the instrument on and off.
3. Zero Adjust
   Thumbwheel adjustment for zeroing out the test lead capacitance.
4. Range Switch
   Selects the desired one of the eight available ranges.
5. Lead Insertion Slots
   Spring contacts spaced for convenient insertion of capacitance leads. Make sure of correct polarity when measuring polarized capacitors.
6. Banana Jacks
   For use with test leads; polarized for use with polarized capacitors.
7. Tilt Bail
   The bail may be removed from its standard position by squeezing the two sides of the bail together and then reinserting the tips in the top holes, thus permitting the capacitance meter to hang in a vertical position.

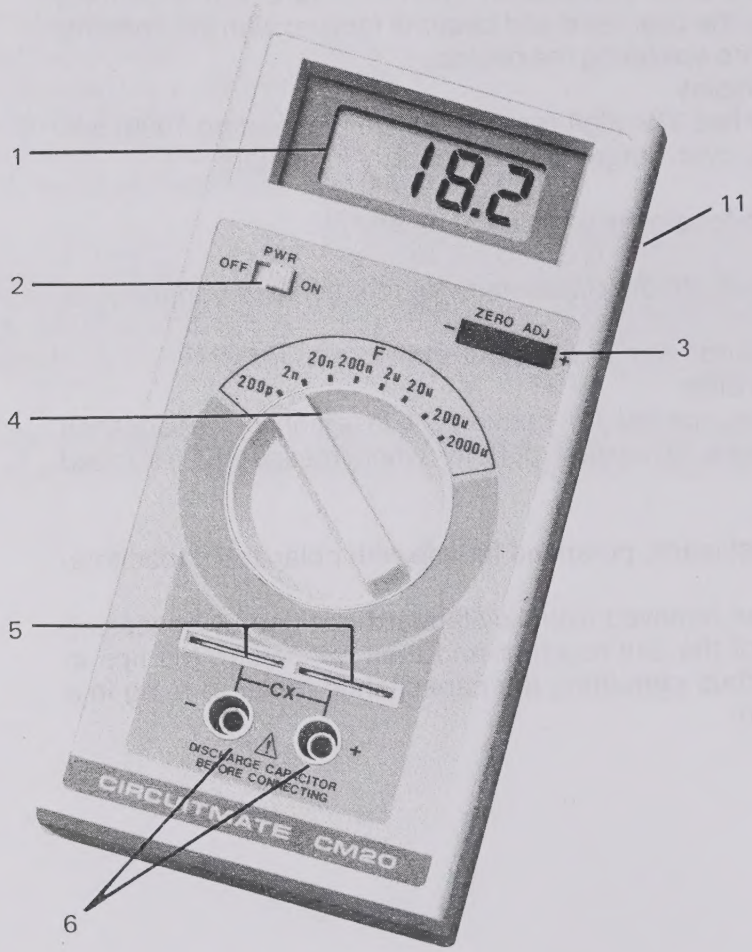

Figure 1. Circuitmate Model CM20 Digital Capacitance Meter

8. Low Battery Indicator
   "LO BAT" displayed when battery voltage drops to 7.0VDC ±0.5VDC.
9. Over-Range Indicator
   Most significant digit of "1" will be displayed, with trailing digits blanked.
10. Anti-Skid Pads
    Provide anti-skid protection when the meter is either lying flat or standing with the bail.
11. AC/DC Adaptor Jack
    Allows plug-in of the optional AC/DC adaptor so the meter can be powered from 120 VAC outlets.

Section Four
OPERATION

4.1 MEASUREMENT PROCEDURE

1. Set Power Switch to "ON."
2. Select the range for the maximum expected capacitance. If the capacitance value is unknown, start with the 200$_{\rho}$F range and keep increasing until the Over-Range Indicator goes off and a reading is obtained.
3. If test leads are to be used, insert them into the banana jacks and use the thumbwheel Zero Adjust to obtain a zero reading on the display.

CAUTION

Discharge any capacitors ***before*** *taking any measurements.*

Never apply a voltage to the test lead input jacks or the capacitor lead insertion slots; failure to observe this precaution can result in serious damage to the meter.

Do ***not*** *short test leads together; this will cause heavy consumption of battery power.*

4. Connect the capacitor to be measured to the test leads or insert the capacitor leads into the insertion slots. Make sure of correct polarities when measuring polarized capacitors.
5. Read the display. If the Over-Range Indicator comes on, select the next higher range. If the display has one or more leading zeros, shift to the next lower range to improve the resolution of the measurement.

4.2 DISPLAY PATTERNS

1. After power to the meter is turned off, it may take a few seconds for disappearance of one or more of the following displays:
   "LO BAT" Indicator
   Erratic Readings
   Minus Sign ("−")
   All of the above displays are normal. The phenomenon is caused by internal filtering capacitors which were charged when power was on.
2. A shorted capacitor will read over-range on all ranges.
3. A capacitor with low voltage leakage will read over-range, or an abnormally high value.
4. An open capacitor will read zero on all ranges except possibly a few ρF on the 200ρF range.
5. A leaky capacitor is indicated by a significant change in the indicated capacitance when the range is changed.
6. Capacitors, especially electrolytics, often have notoriously wide manufacturing tolerances. Unless the capacitor is of a close-tolerance type, do not be surprised if the measured value is greater than the value marked on the capacitor. However, the actual value is seldom drastically below the rated value.

Section Five
SERVICING INSTRUCTIONS

5.1 BATTERY/FUSE REPLACEMENT

WARNING

To prevent electrical shock hazard, turn off capacitance meter and disconnect test leads before removing battery cover. To prevent fire, use only 0.25A/250V fuse.

1. Remove battery cover by pressing down on it and pushing in the direction of the arrows.
2. Replace battery with a standard 9-volt transistor battery.
   Replace fuse with spare furnished with instrument.
3. Replace battery cover.

5.2 CASE AND WINDOW CLEANING

The case and window should be cleaned with a mild solution of detergent and water. Apply sparingly with a soft cloth and allow to dry completely before using.

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These chemicals will react with plastics used in instrument construction.

5.3 RECALIBRATION

1. Perform calibration at an ambient temperature of 23 ±2°C and a relative humidity of 75% or less.
   Allow instrument to stabilize at this temperature for at least thirty minutes.
2. Remove the back cover from the instrument by removing three screws and then lifting off cover. **DO NOT** remove the shield.

5.4 PARTS LIST FOR CIRCUITMATE CM20 LARGE BOARD ASSEMBLY

Item No.	Reference Designation	Beckman Industrial Part No.	Description	Qty
1	R1	3001-050-121	Metal Film Resistor 900K ohms ±0.5% 1/8W Select much ±0.25%	1
2	R2	3001-050-120	Metal Film Resistor 90K ohms ±0.5% 1/8W Select much ±0.25%	1
3	R3	3001-050-119	Metal Film Resistor 9K ohms ±0.5% 1/8W Select much ±0.25%	1
4	R4	3001-050-118	Metal Film Resistor 900 ohms ±0.5% 1/8W Select much ±0.25%	1
5	R5	3001-050-117	Metal Film Resistor 90 ohms ±0.5% 1/8W Select much ±0.25%	1
6	R6	3001-050-116	Metal Film Resistor 10 ohms ±0.5% 1/8W Select much ±0.25%	1
7	R7, 18	3001-010-102	Carbon Film Resistor 10K ohms ±5% 1/8W	2
8	R8, 10, 11, 23, 25	3001-010-104	Carbon Film Resistor 100K ohms ±5% 1/8W	5
9	R9	3001-010-223	Carbon Film Resistor 22K ohms ±5% 1/8W	1
10	R12	3001-050-112	Metal Film Resistor 200K ohms ±1% 1/8W	1
11	R13, 24	3001-050-113	Metal Film Resistor 100K ohms ±1% 1/8W	2

3. Set up the meter with the lead configuration to be used in the recalibration. Insert any test fixture (Kelvin clip, for example) or connect any leads to be used later. (Remember that even very short leads may have a significant effect.)
4. Turn the Range Switch on the Capacitance Meter to the 200$_{\rho}$F position.
5. Adjust the front-panel zero adjust control for 000 display.
6. Connect a standard capacitor whose value is near fullscale on one of the higher ranges, and is known to within ±0.1%. Suggested value is 19 nF.
7. Turn the Range Switch to the appropriate range scale.
8. Adjust VR1 (Figure 2) for a display equal to the known capacitance.
9. Remove the standard capacitor. Replace back cover.

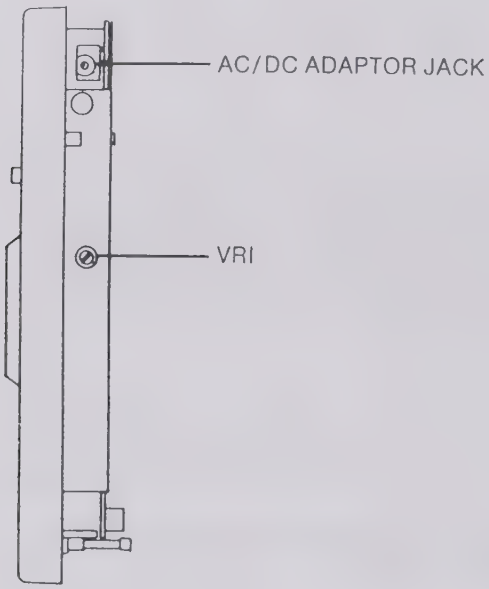

Figure 2. Right-hand Side View of Meter

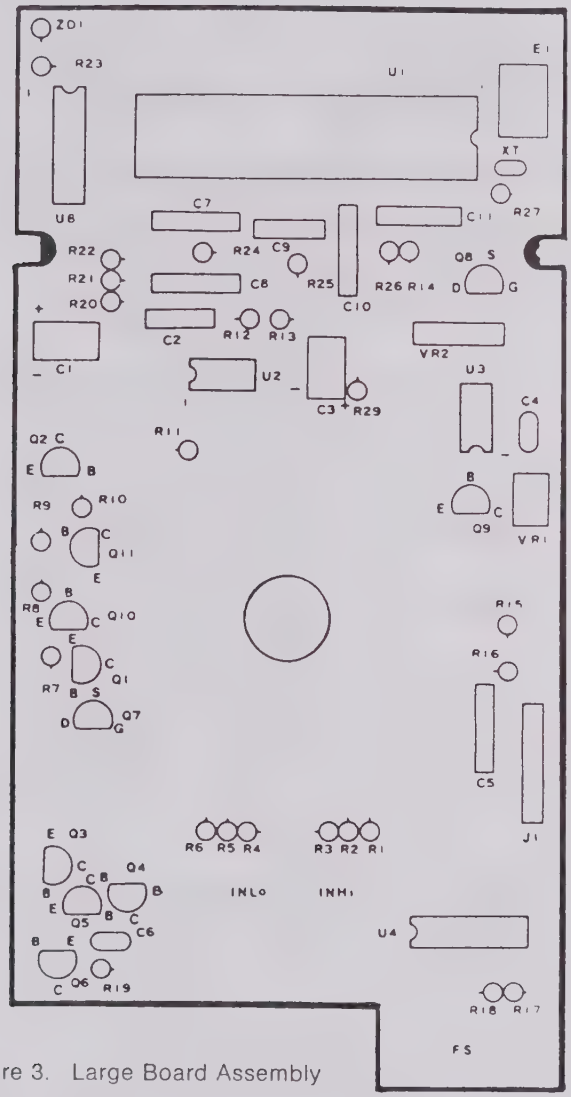

Figure 3. Large Board Assembly

Item No.	Reference Designation	Beckman Industrial Part No.	Description	Qty
12	R15	3001-050-114	Metal Film Resistor 79.6K ohms ±1% 1/8W	1
13	R16	3001-050-115	Metal Film Resistor 9.09K ohms ±1% 1/8W	1
14	R17, 20, 21, 22	3001-010-105	Carbon Film Resistor 1M ohms ±5% 1/8W	4
15	R26	3001-010-824	Carbon Film Resistor 820K ohms ±5% 1/8W	1
16	R19	3001-030-100	Carbon Film Resistor 10 ohms ±5% 1/2W	1
17	R27	3001-050-131	Metal Film Resistor 1M ohms ±2% 1/8W	1
18	R29	3001-010-473	Carbon Film Resistor 47K ohms ±5% 1/8W	1
19	VR1	3001-090-103	Potentiometer 5K ohms ±10% 100ppm	1
20	VR2	3001-090-104	Variable Resistor 1M ohms ±20%	1
21	C1, 3	3001-160-100	Electrolytic Capacitors 10μF $^{+80}_{-20}$% 16V	2
22	C2	3001-130-111	MPE Capacitor 0.1μF ±10% 100V	1
23	C5, 7, 8, 10, 11	3001-130-112	MPE Capacitor 0.22μF ±10% 100V	5

Item No.	Reference Designation	Beckman Industrial Part No.	Description	Qty
24	C9	3001-130-113	MPE Capacitor 0.47μF $\pm$10% 100V	1
25	C4	3001-100-106	Ceramic Capacitor 1000$_\rho$F $\pm$10% 50V	1
26	C6	3001-100-108	Ceramic Capacitor 68$_\rho$F $\pm$5% 50V	1
27	Q7	3001-250-107	JFET J305	1
28	Q8	3001-250-108	JFET J113	1
29	Q1, 4, 5, 6	3001-250-106	Transistors 8050	4
30	Q2, 3	3001-250-104	Transistors 8550	2
31	Q9, 11	3001-250-105	Transistors 1402	2
32	Q10	3001-250-109	Transistor 9015	1
33	U1	3001-270-125	I.C. 7106CPL	1
34	U2, 3	3001-270-118	I.C. TL062CP	2
35	U4	3001-270-119	I.C. HD14016	1
36	U8	3001-270-120	I.C. HD14070	1
37	ZD1	3001-230-100	Diode, Zener	1
38	X'TAL	3001-360-100	Quartz Crystal	1
39	E1	3001-350-100	Battery Eliminator	1

5.5 PARTS LIST FOR CIRCUITMATE CM20 SMALL BOARD ASSEMBLY

Item No.	Reference Designation	Beckman Industrial Part No.	Description	Qty
1	D1	3001-200-101	Diode, 1N4001	1
2	C12, 14	3001-160-100	Electrolytic Capacitors 10μF $^{+80}_{-20}$% 16V	2
3	R28	3001-010-104	Carbon Film Resistor 100K ±5% 1/8W	1
4	C13	3001-100-105	Ceramic Capacitor 100$_\rho$F ±5% 50V	1
5	U5, 6	3001-270-121	I.C. CD4518	2
6	U7	3001-270-122	I.C. CD4017	1
7		3001-370-105	Cable, Flex 7 pins	

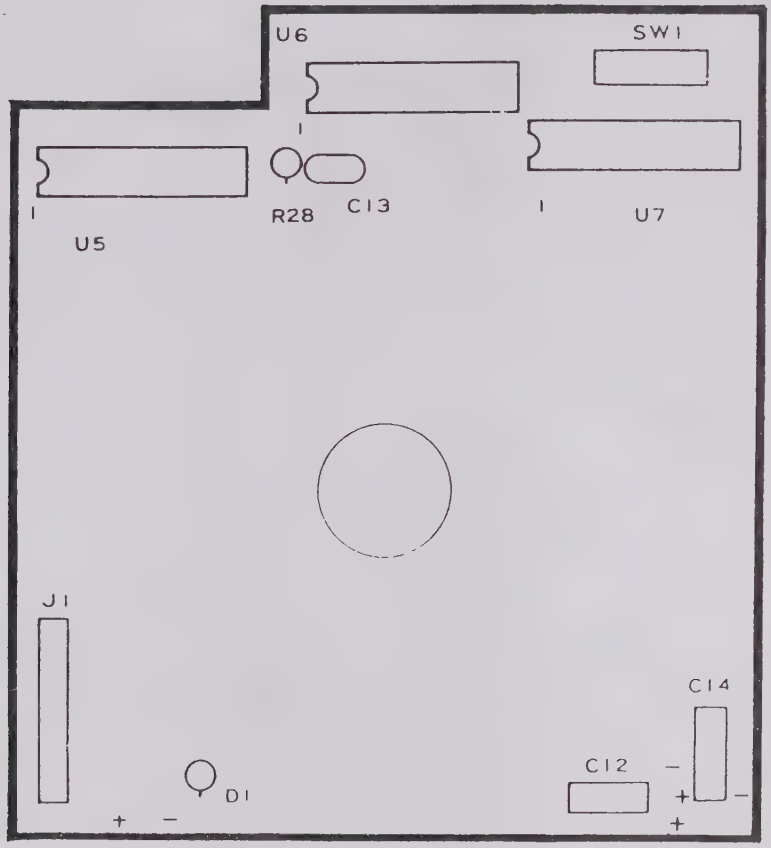

Figure 4. Small Board Assembly

Section Six
SPECIFICATIONS

Specifications are subject to change without notice.

6.1 GENERAL SPECIFICATIONS

Display	• 3½-digit liquid crystal display (LCD) with a maximum reading of 1999.
Overload indication	• Most significant digit of "1" displayed, with all trailing zeros blanked.
Low battery indication	• "LO BAT" displayed when battery voltage drops below 7.0VDC ±0.5VDC.
Measurement rate	• 2.5 measurements per second, nominal.
Operating temperature	• 0°C to +35°C 0-80% RH +35°C to +50°C 0-70% RH
Storage temperature	• −20°C to +65°C 0-90% RH with battery removed.
Accuracy	• Accuracy specified at 23 ±5°C, less than 75% RH.
Power	• Single, standard 9-volt transistor battery, NEDA 1604, JIS 006P, IEC 6F22.
Battery Life	• Approximately 200 hours on alkaline battery or 100 hours on carbon-zinc battery with normal usage.
Dimensions	• 6.85 inches (17.4 cm) long × 3.55 inches (9.0 cm) wide × 1.4 inches (3.6 cm) high.
Weight	• 12 ounces (355 grams) including battery.
Accessories	• Test leads (pair), spare fuse (0.25A). battery, operator's manual, AC/DC adaptor (optional).

6.2 ELECTRICAL SPECIFICATIONS

(At 23°C ±5°C, 75% RH maximum.)

Range accuracy	200$_\rho$F	±0.5% reading, plus 1 count plus 0.5$_\rho$F
	2$_\eta$F	±0.5% reading, plus 1 count plus 0.5$_\rho$F
	20$_\eta$F	±0.5% reading, plus 1 count plus 0.5$_\rho$F
	200$_\eta$F	±0.5% reading, plus 1 count plus 0.5$_\rho$F
	2μF	±0.5% reading, plus 1 count plus 0.5$_\rho$F
	20μF	±0.5% reading, plus 1 count plus 0.5$_\rho$F
	200μF	±1.0% reading, plus 1 count
	2000μF	±2.0% reading, plus 1 count

Range resolution	200$_\rho$F	0.1$_\rho$F
	2$_\eta$F	1$_\rho$F
	20$_\eta$F	10$_\rho$F
	200$_\eta$F	100$_\rho$F
	2μF	1000$_\rho$F
	20μF	0.01μF
	200μF	0.1μF
	2000μF	1μF

Battery current	3.0 mA DC max.	if no capacitor load
	15.0 mA DC max.	if max. capacitor load

Zero adjust range: 20$_\rho$F minimum

Excitation voltage: 3.2VAC maximum

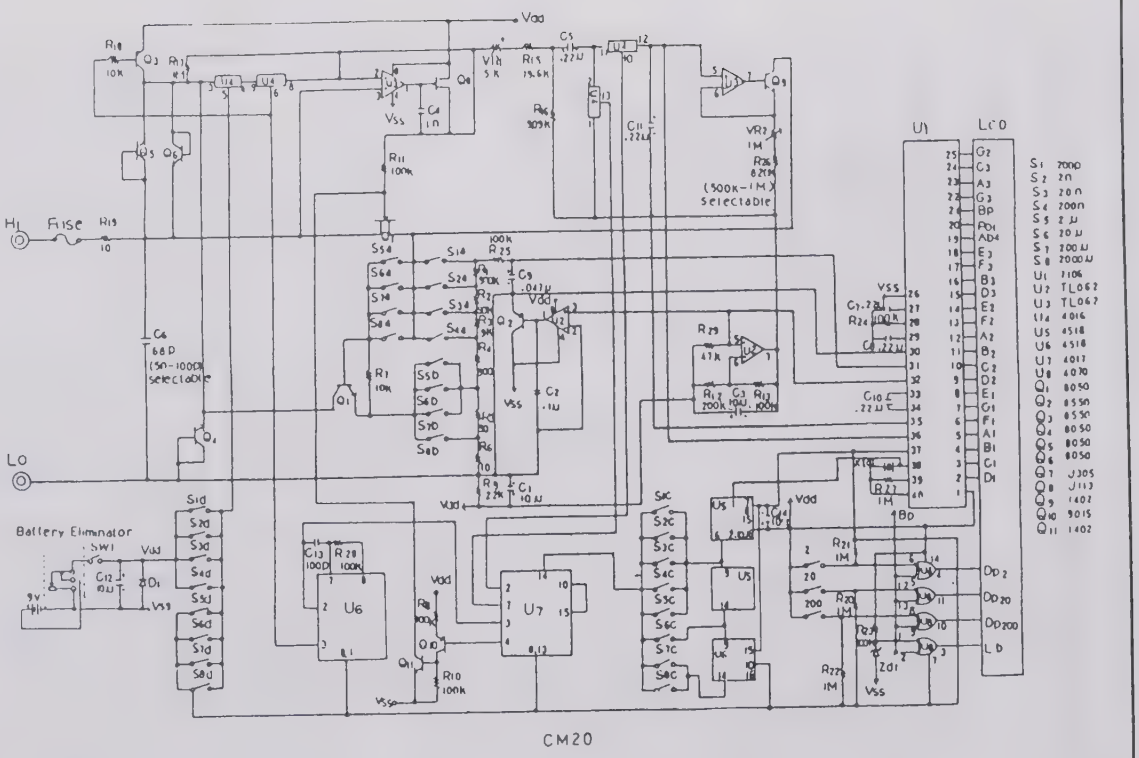

Figure 5. Schematic Wiring Diagram of CM20

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